Management of Hypertonia

A Rehabilitative and Surgical Perspective

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Pediatric Rehabilitation Medicine

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Disclosures

- **I have no actual or potential conflict of interest in relation to this program.**

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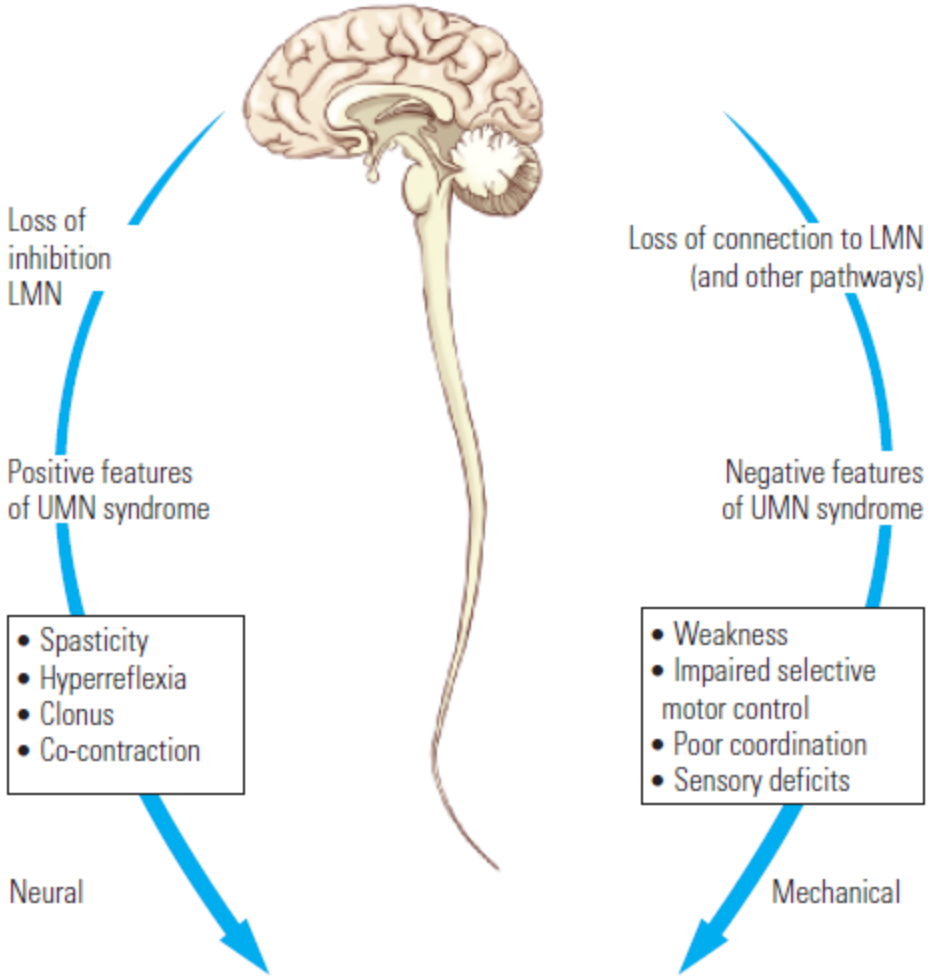
Objectives

- Define the term “spasticity”
- Define the term “dystonia” in comparison to spasticity
- Review non-surgical pharmacologic options for treatment of generalized and focal hypertonia
- Explain how Intrathecal Baclofen (ITB) and Selective Dorsal Rhizotomy (SDR) reduce spasticity
- Describe the patient selection criteria for ITB, SDR and SVDR evaluation of a child who might benefit from an SDR vs Intrathecal Baclofen Therapy vs SVDR
- Explain the surgical approach to an SDR
- Explain the postoperative recovery and rehabilitation care plan after SDR
- Describe the outcomes expected from an SDR and SVDR

Causes of Hypertonicity

- Injury to the brain
  - **Cerebral Palsy (CP)**
  - Traumatic brain injury
  - Anoxic brain injury
  - Brain malformations
- Spinal cord injury
- Progressive disease impacting CNS
  - Leukodystrophy*
  - Hereditary spastic paraplegia*
  - Multiple Sclerosis (MS) *
  - Other genetic disorders*



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Cerebral Palsy

The diagnosis of Cerebral palsy is an umbrella term for a static (i.e. non-progressive) injury to the developing fetal or infant brain resulting in both cognitive and motor impairments

Classification of Cerebral Palsy

Topography (body parts affected)

Type of movement disorder (main type involved)

Functional abilities

Type of Movement Disorder

Motor types

SPASTIC: ~80%

Most common form of CP. Muscles appear stiff and tight. Arises from damage to the Motor Cortex.

ATAXIC: ~1-10%

Characterised by shaky movements. Affects balance and sense of positioning in space. Arises from damage to the Cerebellum.

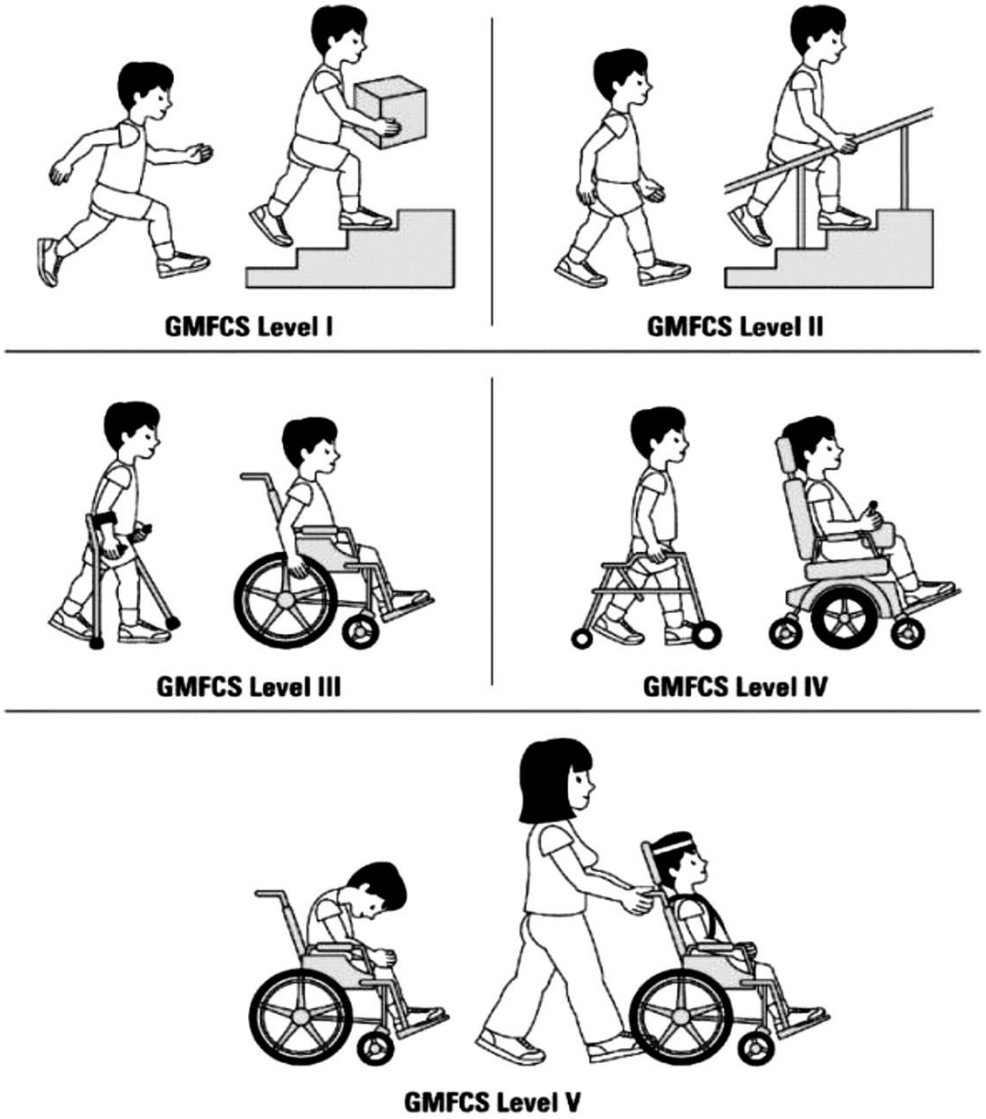
DYSKINETIC: ~10-20%

Characterised by involuntary movements such as dystonia, athetosis and/or chorea. Arises from damage to the Basal Ganglia.

MIXED TYPES

A number of children with CP will have two motor types present, e.g. spasticity and dystonia.

Gross Motor Function Classification Scale (GMFCS)



What is spasticity?

- Velocity dependent tone
- Disruption of the Upper Motor Neuron (UMN) pathways at cerebral cortex/brainstem/spinal cord
  - “Upper Motor Neuron Syndrome”
- *Spastic cerebral palsy is caused by damage to the motor cortex during critical periods of brain development, in utero or within the first few years of life
  - Infection
  - Stroke
  - Prematurity
- Severity of movement impairments depends on
  1. Where the brain is damaged/underdeveloped/impaired and
  2. How severe the damage is

What is dystonia?

Sustained/ intermittent muscle contractions

- twisting, repetitive patterned movements or abnormal postures

Thought to be due to an interruption of the cortical-basal ganglia-cortical loops

- Neurons in the internal globus pallidus fire slowly and erratically
- Supplementary motor cortex and premotor cortex become excessively stimulated

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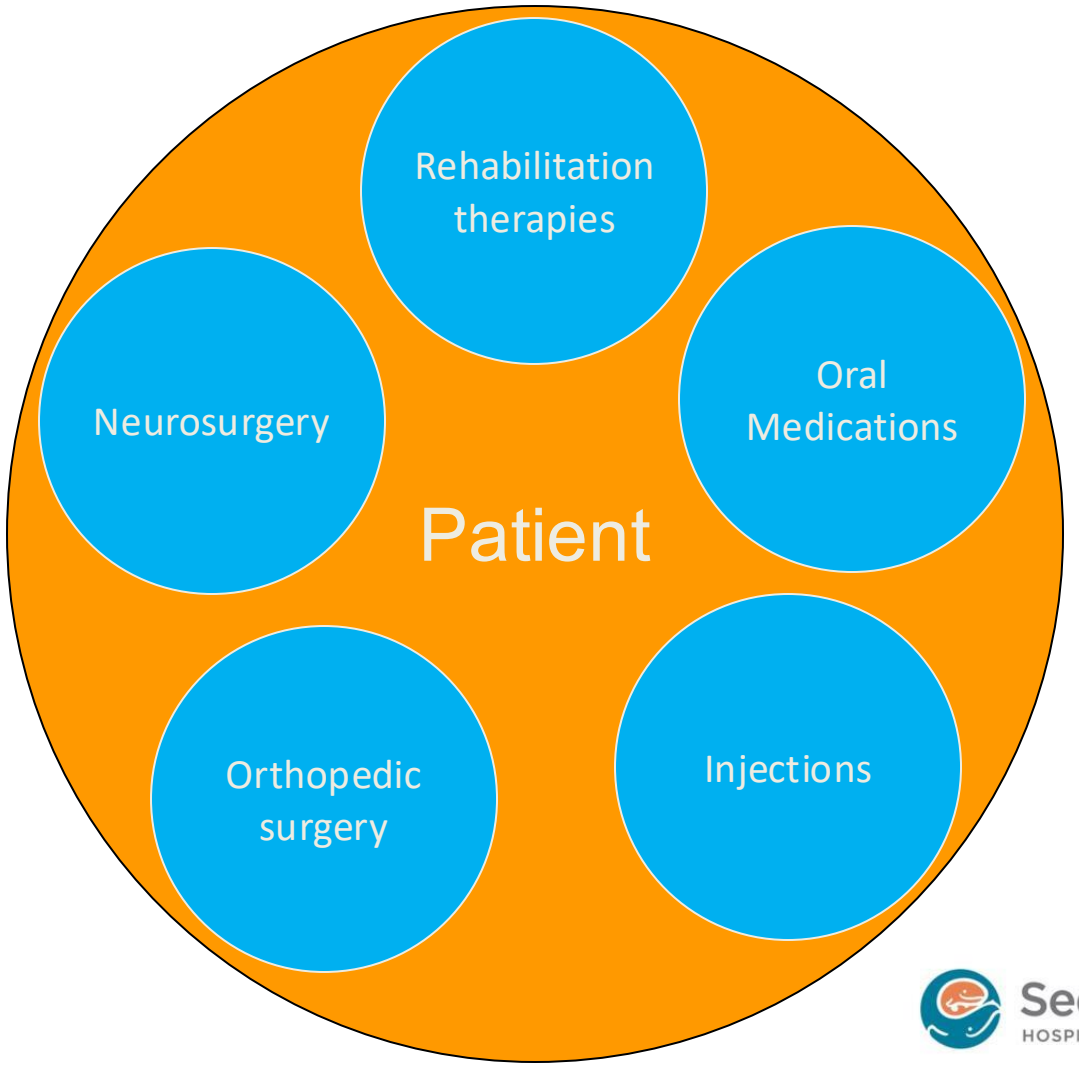
Treatment of Hypertonia



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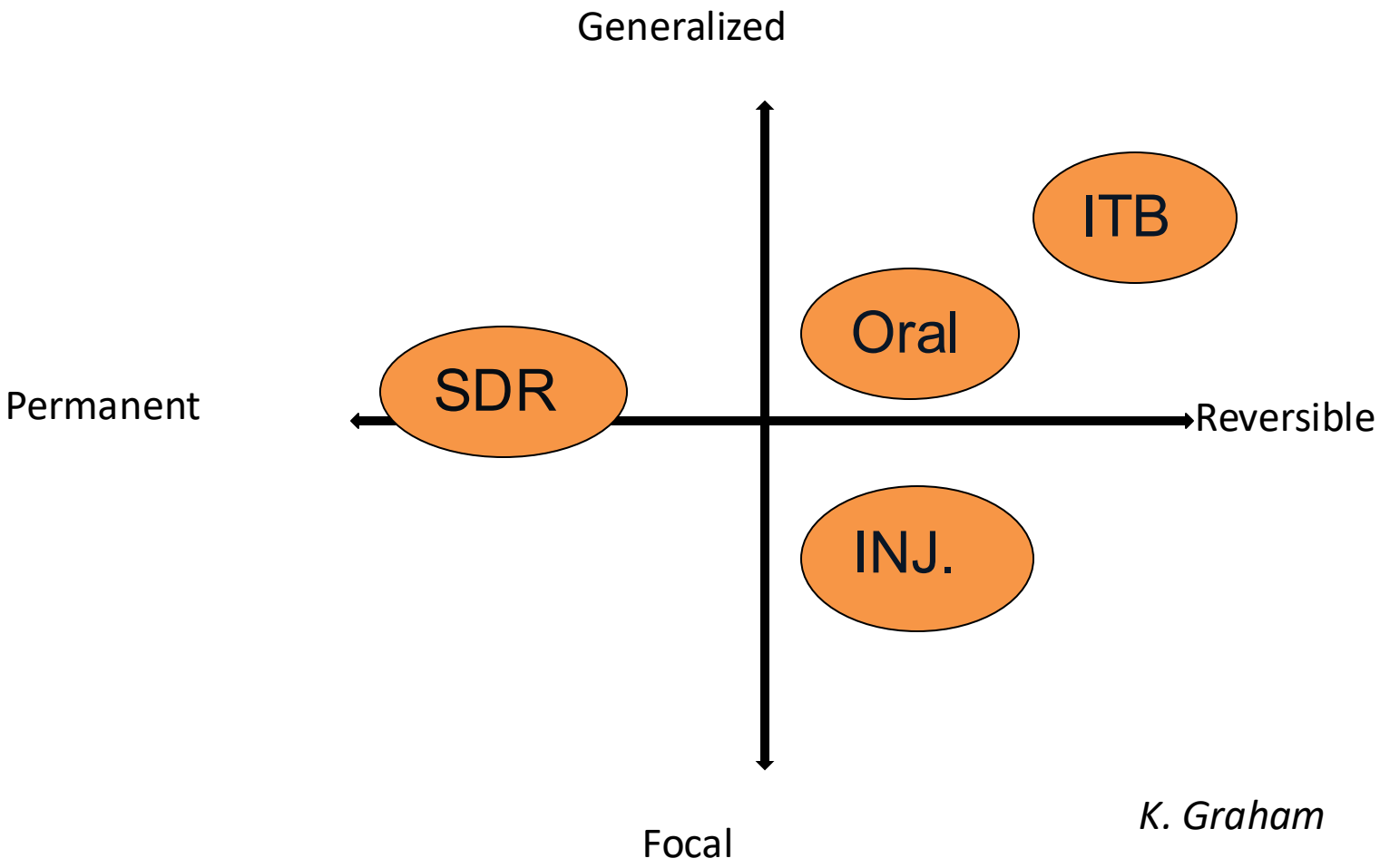
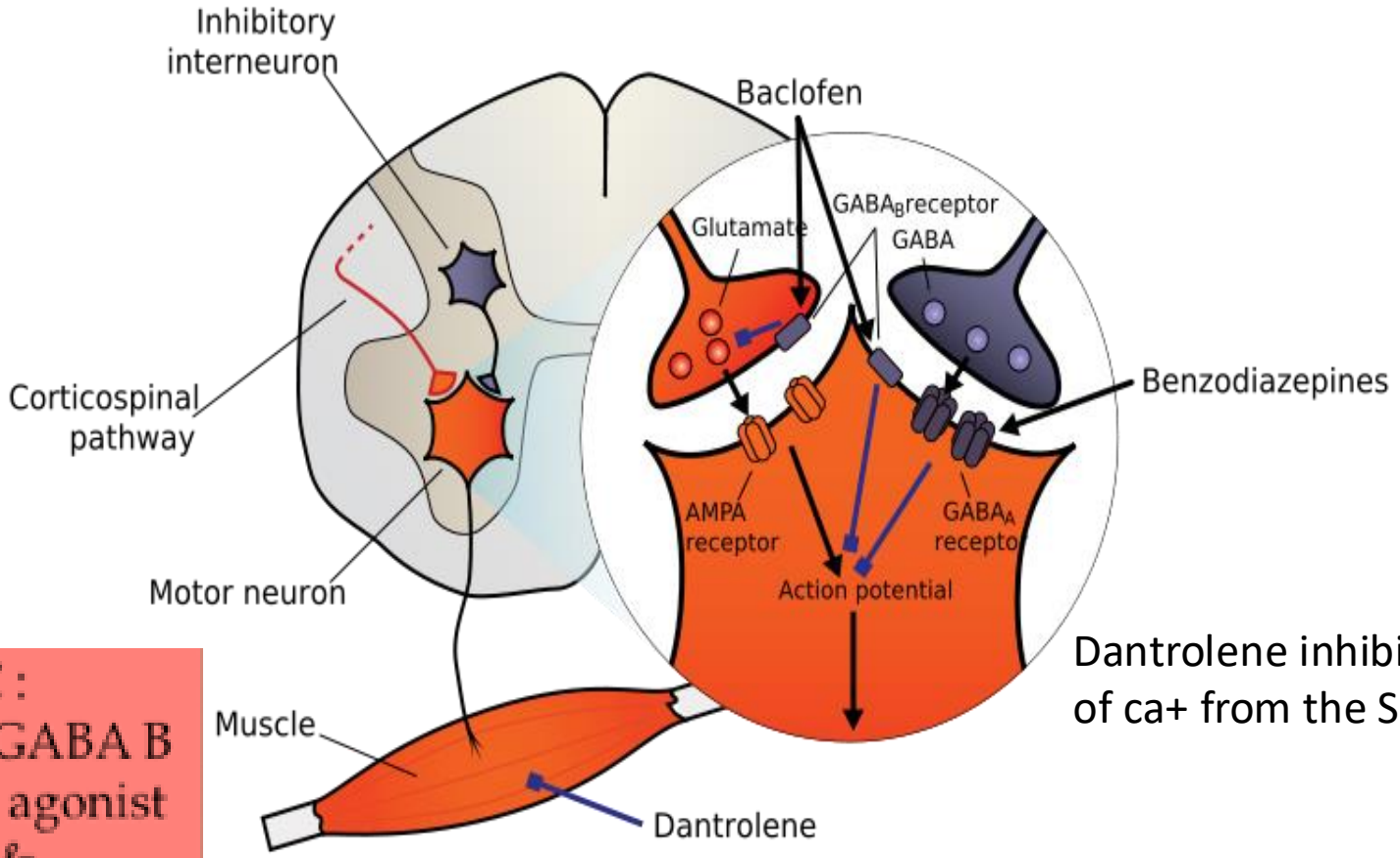
Spasticity Compass



MOA of commonly used oral meds



Dantrolene inhibits release of ca+ from the SR

Brain & SC :
Baclofen - GABA B agonist
Diazepam & Clonazepam - GABA A agonist
Tizanidine - Alpha 2 agonist

Image from Frontiers in Human Neuroscience 2013

Medication	Dosing	Adverse effects
Baclofen	1-4 y/o: 2.5-5mg BID-TID 5-12 y/o: 2.5-10mg TID Max. dose=80mg/day	Sedation, CNS depression, fatigue, weakness, constipation acute withdrawal : hallucination, seizure, pruritus, severe hypertonia
Diazepam	0.12-0.8mg/kg/day div. q6-8 hrs.	Sedation, CNS & resp. depression, fatigue, weakness, hypotension, hallucinations
Clonazepam	0.01-0.03mg/kg/day div. BID/TID	Sedation, dizziness, ataxia, fatigue, CNS depression, LFT & CBC monitoring if long term use
Tizanidine	0.5-1mg TID, gradually titrate up Max. dose = 6mg/day	Sedation, fatigue, weakness, N/V, loss of appetite, hallucination, hypotension, liver toxicity
Dantrolene Sodium	0.5mg/kg/dose BID, gradually titrate up to max. of 3mg/kg	lightheadedness, vertigo, weakness, malaise, diarrhea, +/- sedation, hepatotoxic* (check LFT's q6mos.)

From Green LB, Hurvitz EA: Cerebral palsy, *Phys Med Rehabil Clin North Am* 18:859-882

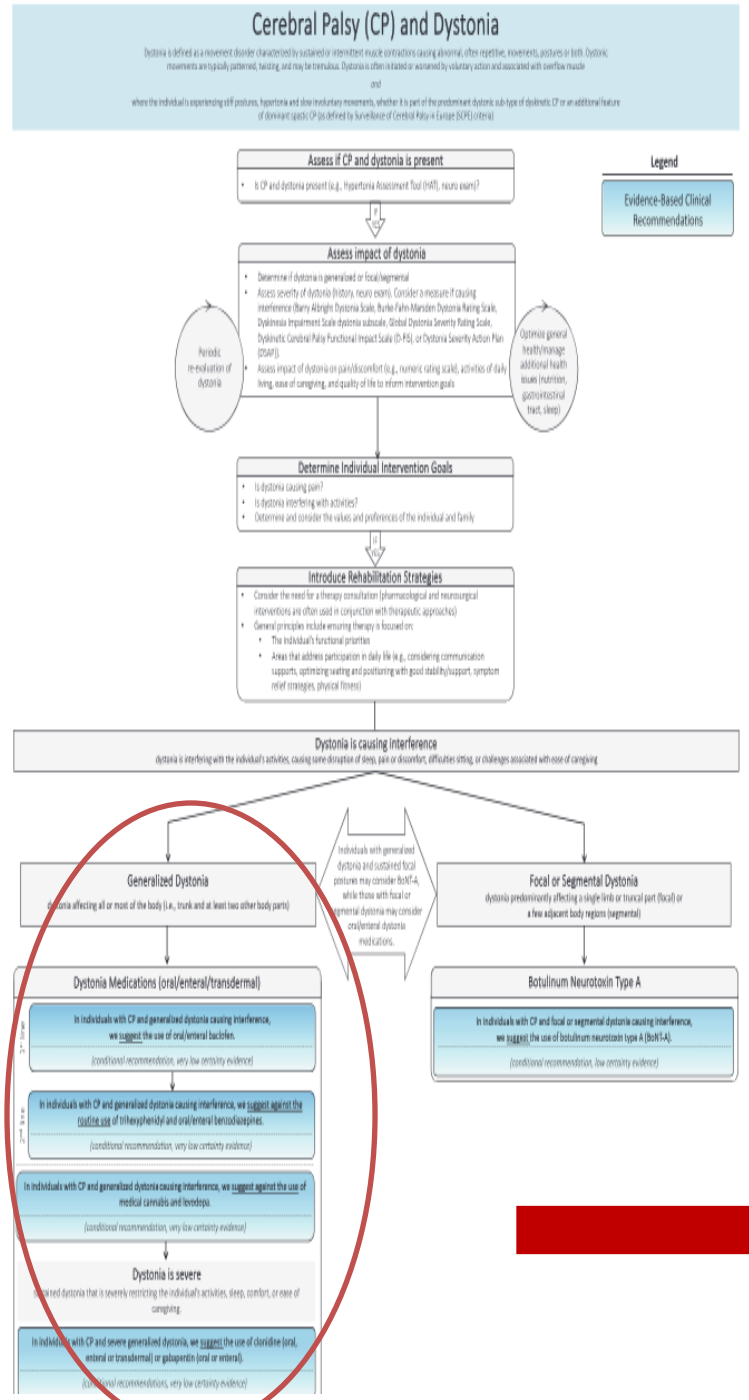
Oral Medications for Dystonia

CLINICAL PRACTICE GUIDELINE

AACPDM

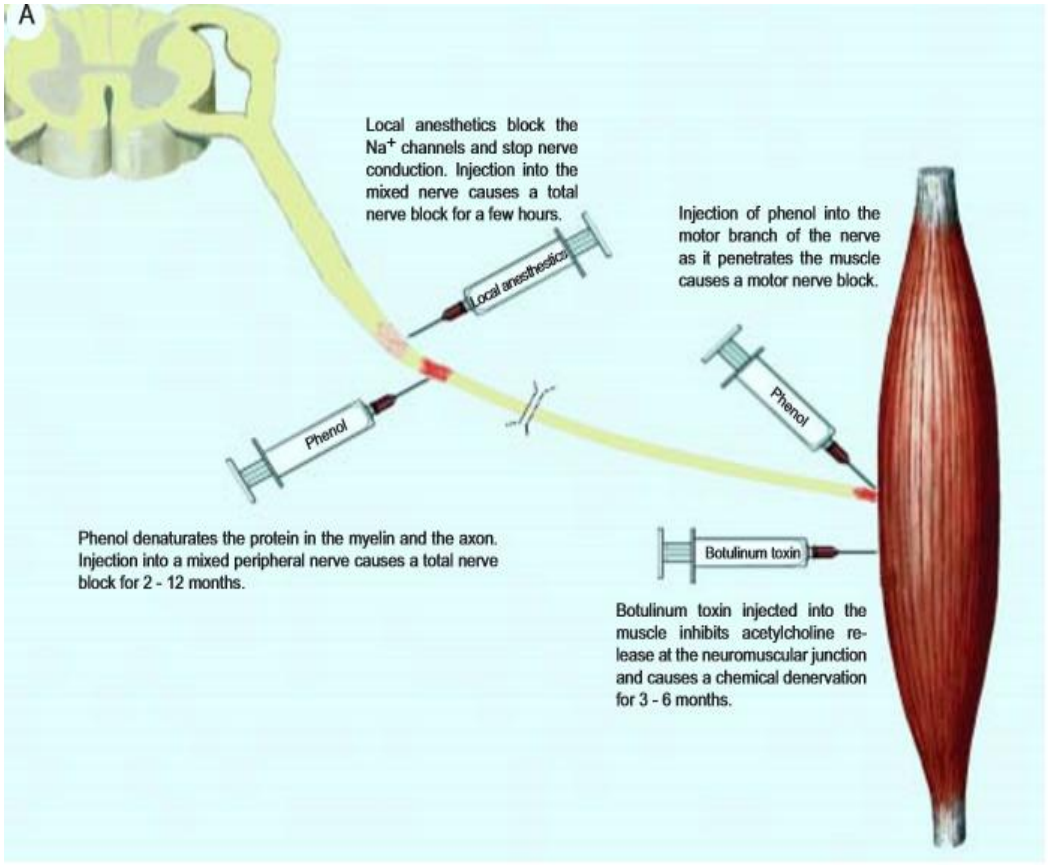
Pharmacological and neurosurgical management of cerebral palsy and dystonia: Clinical practice guideline update

Darcy Fehlings[1] | Brenda Agnew[2] | Hortensia Gimeno[3] | Adrienne Harvey[4] | Kate Himmelmann[5] | Jean-Pierre Lin[6] | Jonathan W. Mink[7] | Elegast Monbaliu[8] | James Rice[9] | Emma Bohn[1] | Yngve Falck-Ytter[10]


Cerebral Palsy (CP) and Dystonia
Dystonia is defined as a movement disorder characterized by sustained or intermittent muscle contractions causing abnormal, often repetitive, movements, postures or both. Dystonic movements are typically patterned, twisting, and may be tremulous. Dystonia is often initiated or worsened by voluntary action and associated with overflow muscle
and
where the individual is experiencing stiff postures, hypertonia and slow involuntary movements, whether it is part of the predominant dystonic sub-type of dyskinetic CP or an additional feature of dominant spastic CP (as defined by Surveillance of Cerebral Palsy in Europe (SCPE) criteria)
Assess if CP and dystonia is present
Is CP and dystonia present (e.g., Hypertonia Assessment Tool (HAT), neuro exam)?
Assess impact of dystonia
Determine if dystonia is generalized or focal/segmental
Assess severity of dystonia (history, neuro exam). Consider a measure if causing interference (Barry Albright Dystonia Scale, Burke-Fahn-Marsden Dystonia Rating Scale, Dyskinesia Impairment Scale dystonia subscale, Global Dystonia Severity Rating Scale, Dyskinetic Cerebral Palsy Functional Impact Scale (D-FIS), or Dystonia Severity Action Plan (DSAP))
Assess impact of dystonia on pain/discomfort (e.g., numeric rating scale), activities of daily living, ease of caregiving, and quality of life to inform intervention goals
Periodic re-evaluation of dystonia
Optimize general health/manage additional health issues (nutrition, gastrointestinal tract, sleep)
Determine Individual Intervention Goals
Is dystonia causing pain?
Is dystonia interfering with activities?
Determine and consider the values and preferences of the individual and family
Introduce Rehabilitation Strategies
Consider the need for a therapy consultation (pharmacological and neurosurgical interventions are often used in conjunction with therapeutic approaches)
General principles include ensuring therapy is focused on:
The individual's functional priorities
Areas that address participation in daily life (e.g., considering communication supports, optimizing seating and positioning with good stability/support, symptom relief strategies, physical fitness)
Legend
Evidence-Based Clinical Recommendations
Dystonia is causing interference
dystonia is interfering with the individual's activities, causing some disruption of sleep, pain or discomfort, difficulties sitting, or challenges associated with ease of caregiving
Generalized Dystonia
dystonia affecting all or most of the body (i.e., trunk and at least two other body parts)
Individuals with generalized dystonia and sustained focal postures may consider BoNT-A, while those with focal or segmental dystonia may consider oral/enteral dystonia medications.
Focal or Segmental Dystonia
dystonia predominantly affecting a single limb or truncal part (focal) or a few adjacent body regions (segmental)
Dystonia Medications (oral/enteral/transdermal)
1st line
In individuals with CP and generalized dystonia causing interference, we suggest the use of oral/enteral baclofen.
(conditional recommendation, very low certainty evidence)
2nd line
In individuals with CP and generalized dystonia causing interference, we suggest against the routine use of trihexyphenidyl and oral/enteral benzodiazepines.
(conditional recommendation, very low certainty evidence)
In individuals with CP and generalized dystonia causing interference, we suggest against the use of medical cannabis and levodopa.
(conditional recommendation, very low certainty evidence)
Dystonia is severe
sustained dystonia that is severely restricting the individual's activities, sleep, comfort, or ease of caregiving.
In individuals with CP and severe generalized dystonia, we suggest the use of clonidine (oral, enteral or transdermal) or gabapentin (oral or enteral).
(conditional recommendations, very low certainty evidence)
Botulinum Neurotoxin Type A
In individuals with CP and focal or segmental dystonia causing interference, we suggest the use of botulinum neurotoxin type A (BoNT-A).
(conditional recommendation, low certainty evidence)

Focal/Segmental treatment

- Botulinum toxin injections – chemodenervation
- Phenol 3-5% or Alcohol – chemoneurolysis or selective motor nerve block



Botulinum Toxins

- 8-18 units/kg per event , up to 300 U TBW
- Single event, multi-level injection
- Intervals between injections : at least 12 wks
- May be up to 3-4 times per year
- Systemic adverse events following BoNTA inj,1-2% , and are associated with increasing co-morbidities and dose of botulinum toxin
- In 2009, FDA Black Box warning added: possibility of distant spread of toxin beyond the treatment area, with possibility of breathing, swallowing difficulties and risk of death.
- Local adverse events : pain, bruising at injection sites
- Ultrasound guidance, EMG, E-stim >> anatomic localization
- As an adjunct to other treatment modalities such as physical/occupational therapy, serial casting, orthosis/bracing

Vova J 2021

Botulinum Toxin

JB&JS REVIEWS

Sarcopenia, Cerebral Palsy, and Botulinum Toxin Type A

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Jamil Manji, MSc, MD

Min Jia Tang, MBBS

Walter Herzog, PhD

Jason J. Howard, BEng, BMedSci, MD, FRCSC

H. Kerr Graham, MD, FRACS

Abstract

» Sarcopenia is common in both the elderly and children with cerebral palsy.

» Children with cerebral palsy have muscles that are much smaller than muscles in typically developing peers.

» Injections of botulinum toxin type A (BoNT-A) result in acute muscle atrophy in animal models and in human subjects.

» It is not known when or if muscles recover fully after injection of BoNT-A.

» These findings have implications for management protocols.

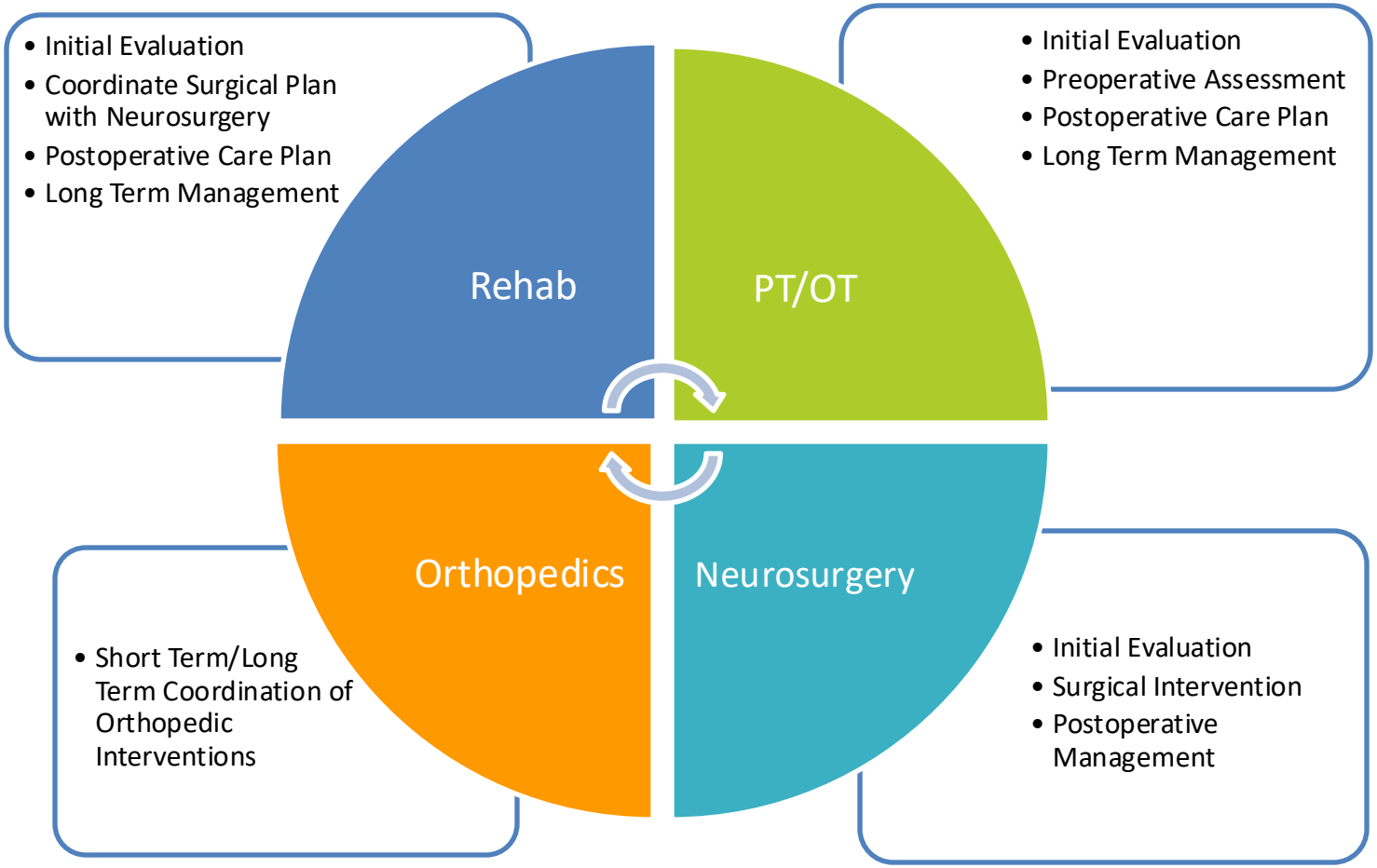
Phenol 3-6% Chemoneurolysis

- Selective motor nerve block : Obturator nerve for hip adductors; Musculocutaneous nerve for elbow flexor, tibial nerve for ankle plantarflexors
- More uncomfortable, burns
- Effect is immediate and longer lasting than Botulinum toxin
- Need electrical stimulation and/or ultrasound guidance, and sedation in children
- Main AE : paresthesia/allodynia

Surgical Tone Management Program

- Intrathecal Baclofen Therapy (ITB)
- Intraventricular Baclofen Therapy (IVB)
- Deep Brain Stimulator * (DBS)
- Selective Dorsal Rhizotomy (SDR)
- Selective Dorsal Ventral Rhizotomy (SVDR)

Comprehensive Evaluation Process



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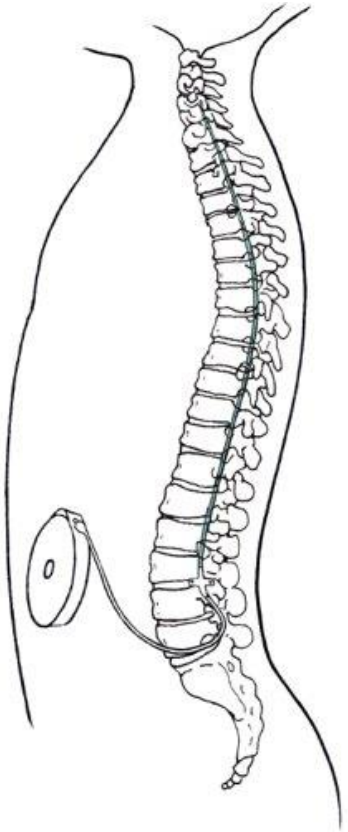
What is a baclofen pump

A "baclofen pump" is a fully implantable drug delivery system for administration of baclofen directly to the spinal fluid:

- **Pump** – implanted in the lower quadrant of the abdomen (most commonly on the right)
- **Catheter** – tip in the intrathecal space and tunneled subcutaneously to pump pocket
- **Tablet Programmer** - dose and other pump settings are adjusted noninvasively via telemetry



ITB Patient Selection

- Patient selection is essential to therapeutic success
- Selection criteria:
  - Have spasticity of spinal or cerebral origin that is refractory to oral baclofen or have experienced intolerable side effects at effective doses
  - Sufficient body mass to support pump bulk and weight (Usually >15kg)
  - Social environment conducive to frequent refills (at least every 6 months)
  - Able to reach ITB provider in case of emergency
  - *Demonstrate positive response to single bolus dose of intrathecal baclofen via lumbar puncture (baclofen test dose)**

Goal setting & patient selection are ***key!!!***

- Goals
  - Improve functional mobility
  - Improve comfort and ease of caregiving
  - Improve positioning

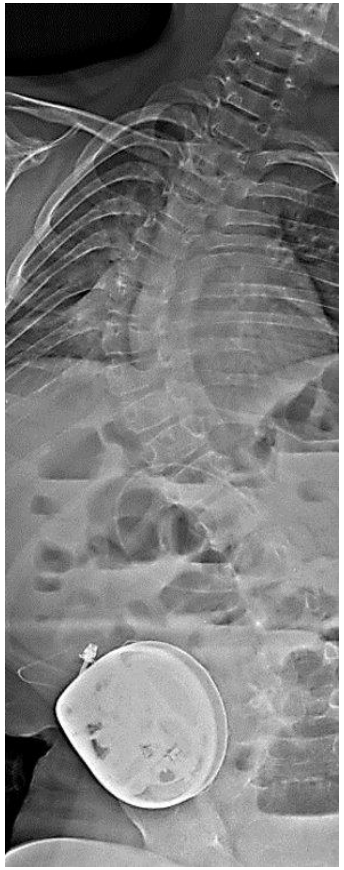
- Catheter level depends on topography and type of hypertonia

- Will not change fixed musculoskeletal deformities

- May unmask weakness so dose may need to be titrated to allow use of some spasticity

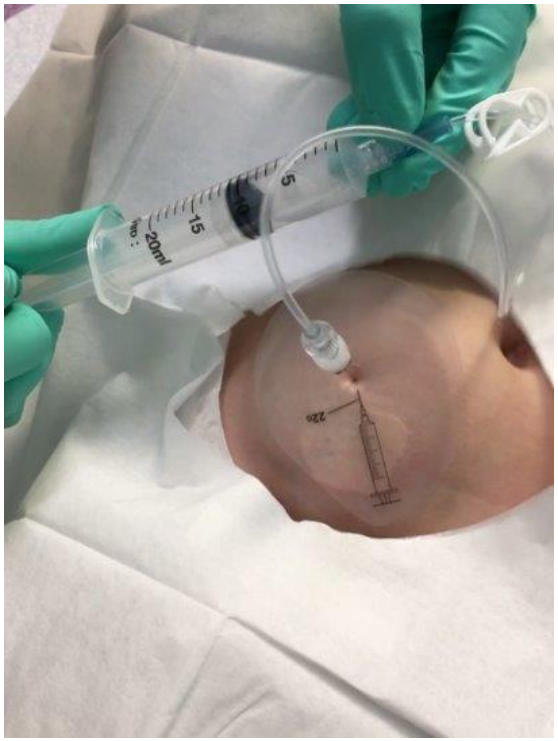
Benefits of ITB

- Lower dose
- Fewer side effects
- Medication titration
- Effective in treating dystonia and spasticity
- Reversible
- Works for legs, trunk, arms, neck, face
- ITB test dose to evaluate response prior to implant



Therapy Maintenance and Risks

- Pump refills
- Pump replacement about every 6+ years
- Risk of pump failure, catheter failure
- Surgical risks
  - Infection
  - Spinal fluid leak
- Baclofen withdrawal
- Baclofen overdose

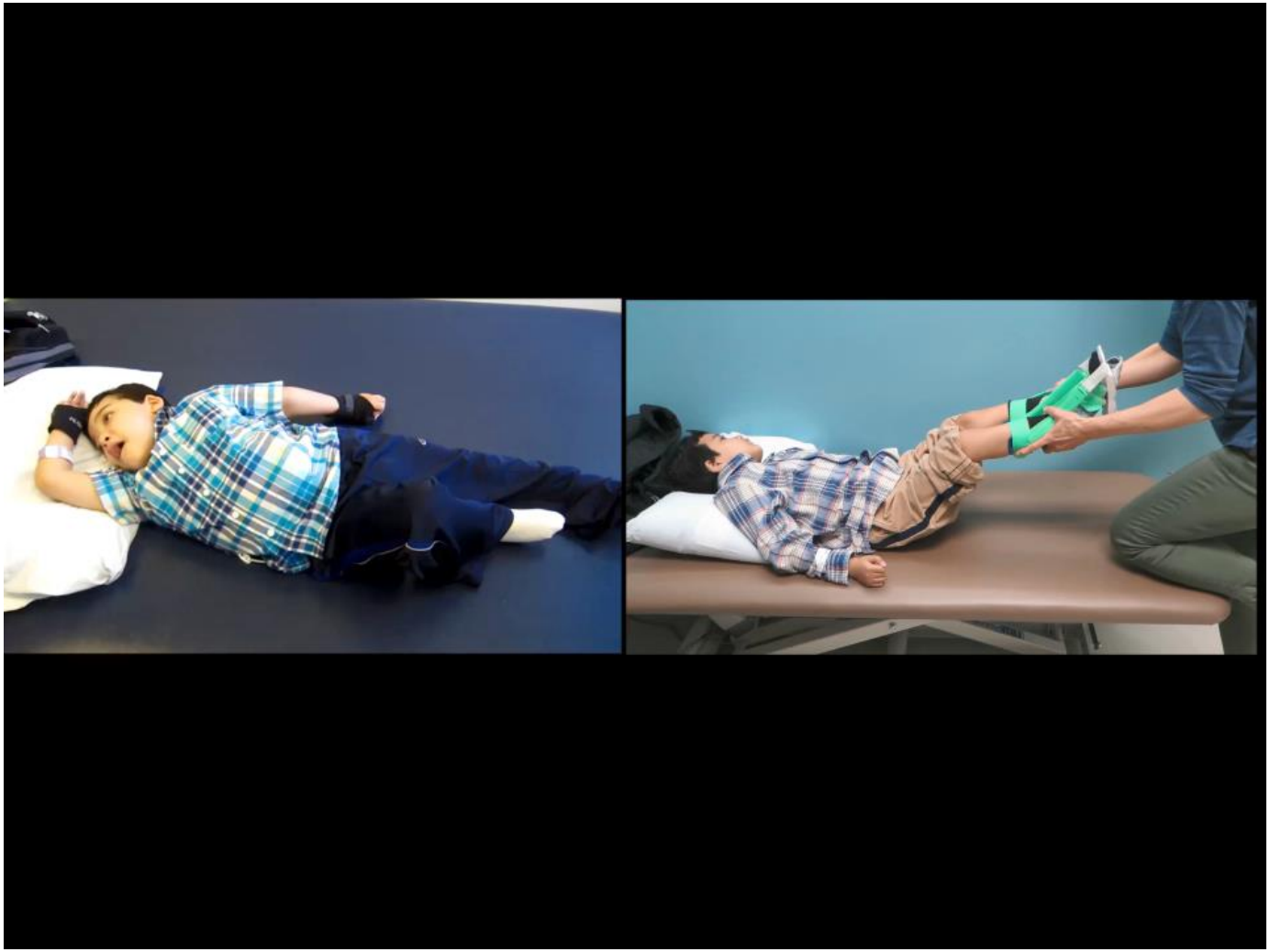


Outcomes of ITB

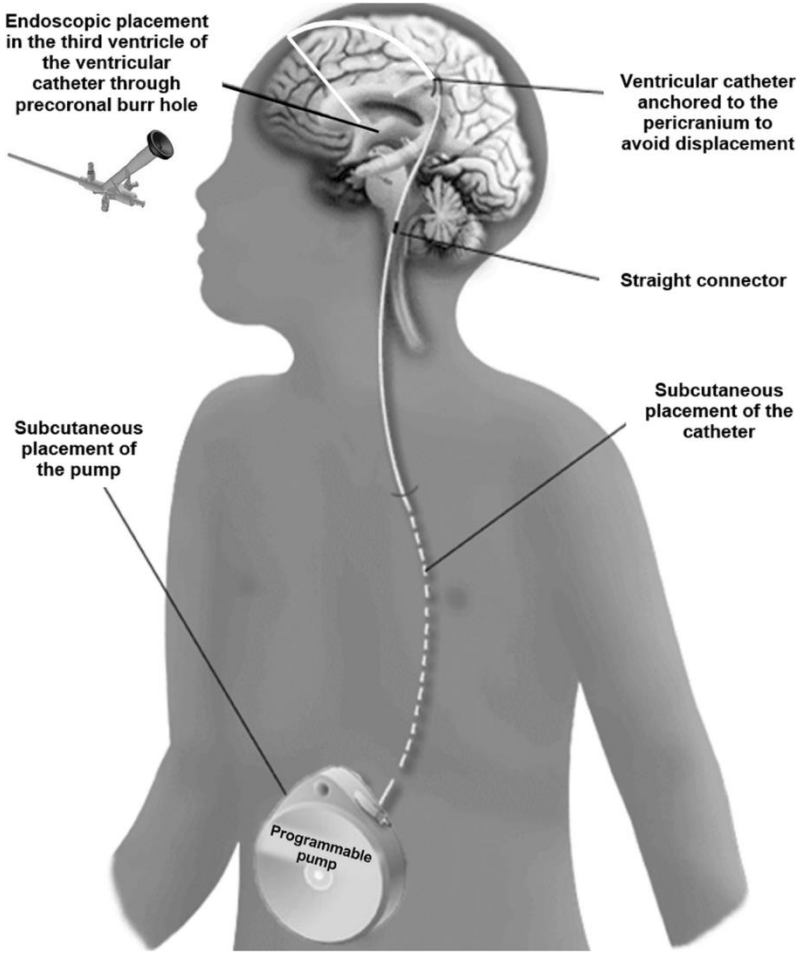
- Functional (GMFCS II, III)
  - Decreases spasticity
  - Improves gait
- Care/Comfort (GMFCS IV, V)
  - 78% decrease in dystonia at rest
  - 48% decrease in dystonia during activity
  - Improvements in self care, communication, sitting and fine motor function

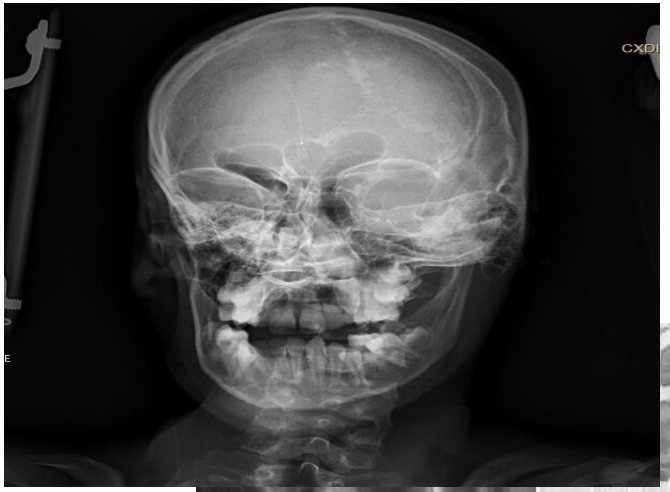
Brochard et al. 2009
Eek et al. 2018

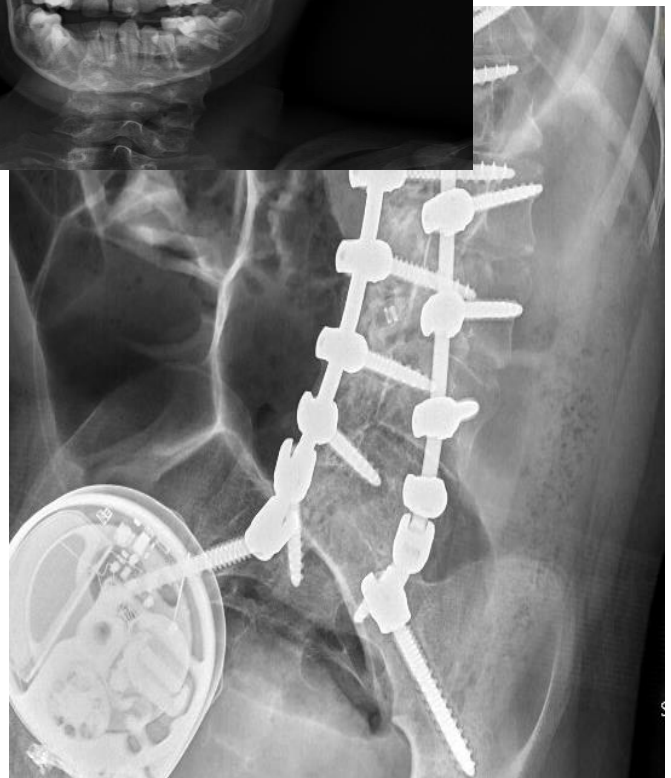
ITB Patient example



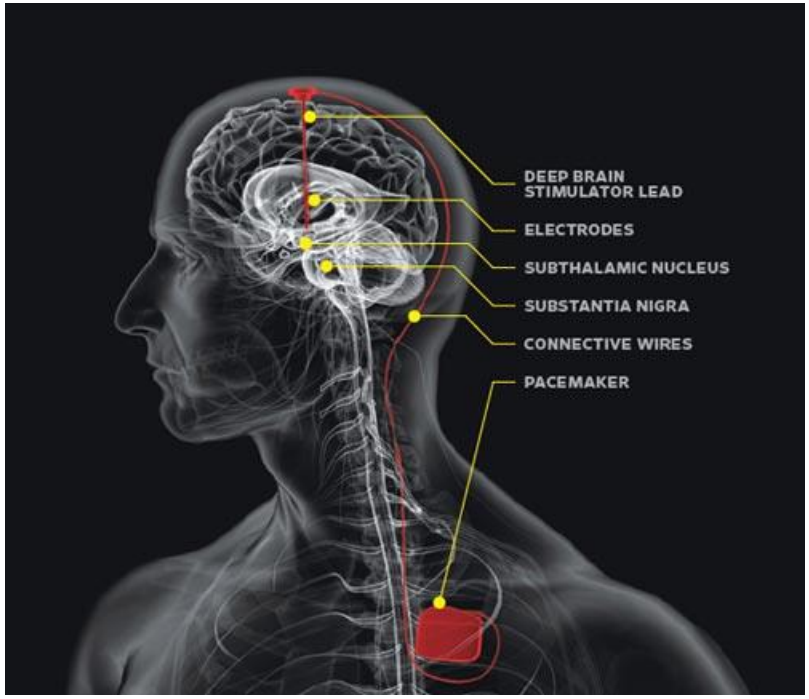
IVB


Endoscopic placement in the third ventricle of the ventricular catheter through precoronal burr hole
Ventricular catheter anchored to the pericranium to avoid displacement
Straight connector
Subcutaneous placement of the catheter
Subcutaneous placement of the pump
Programmable pump





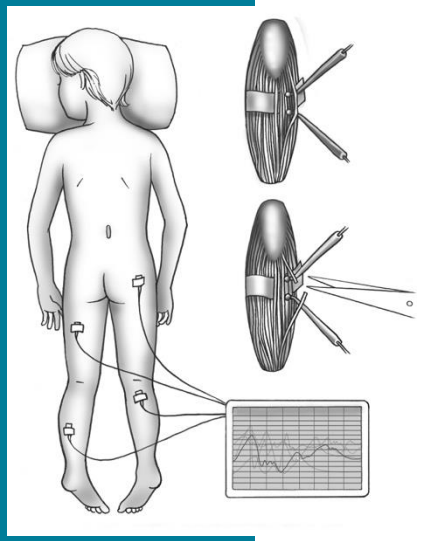
Deep Brain Stimulation



- Primary/genetic dystonias & Parkinsons
- May help motor non motor symptoms
- Applications now include dyskinetic and dystonic CP- ot sufficient evidence
- Outcome of DBS in dystonic CP Variable: 15-50% motor improvement, could be slightly lower and higher depending on the studies.
- Some studies showed that dystonic CP patients may take up to 24 months to observe these benefits.

Anchietta 2025

What is Selective Dorsal Rhizotomy ?



Selective Dorsal Rhizotomy is a surgery to expose and cut abnormal sensory spinal nerves that contribute to ***spasticity***.

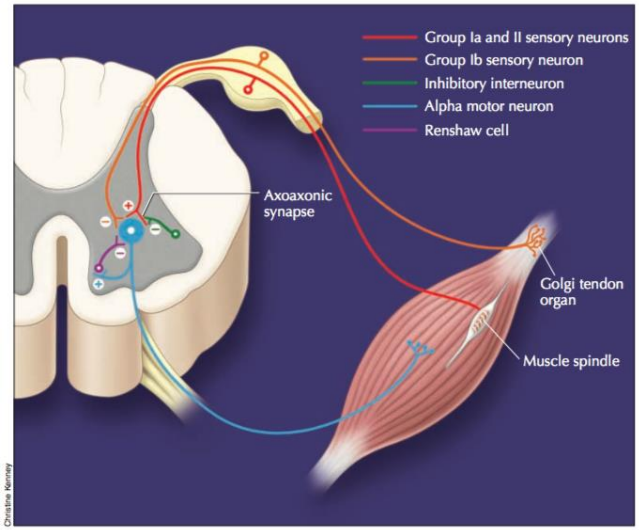
“Selective” refers to the identification of those specific nerves that are both innervating the muscle groups negatively impacting the patient’s function and gait and responding abnormally to electrical stimulation.

“Dorsal” (or sensory) refers to the type of nerve being targeted.

“Rhizotomy” refers to the cutting of that nerve.

How SDR Treats Spasticity

- How a stretch reflex works:
  - Sensory input from the muscle
  - Integration of sensory information in the spinal cord
  - Output of information to the muscle
- How spasticity affects this:
  - Loss of inhibition from the brain → over-activity of the muscle
- How SDR affects this:
  - Decreases sensory input into the spinal cord → decreasing abnormal muscle output



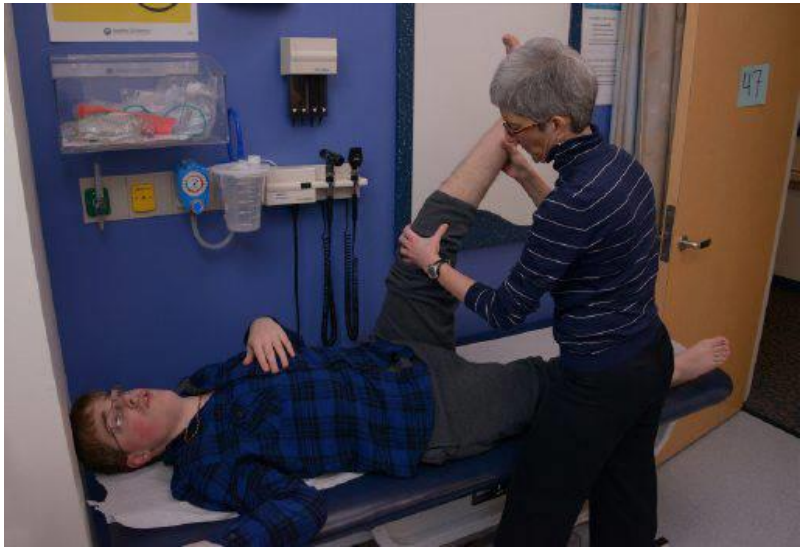
Satkunam, CMAJ, 2003

SDR Patient Selection Criteria

- Any age (typical age range 3 – 8 years)
- Diagnosis consistent with CP
- Spasticity predominant movement disorder
- Little to no dystonia
- Good strength and motor control
- ROM adequate
  - May consider combining SDR with orthopedic muscular procedures such as tendon lengthening
- Good potential for rehabilitation
  - Patient/family commitment
  - Access to therapies
- Patient and family/medical team goals in alignment

SDR Evaluation – Examination

- General
- Musculoskeletal
  - ROM
  - Hips
- Neurological
  - Tone (spasticity vs dystonia)
  - Reflexes
- Neuromuscular
  - Strength



SDR Evaluation - Function

- Gait
- Motor control
- Transitional movements
- Objective information/testing
  - GMFM
  - GMFCS
  - BAD
- Equipment
  - Orthotics

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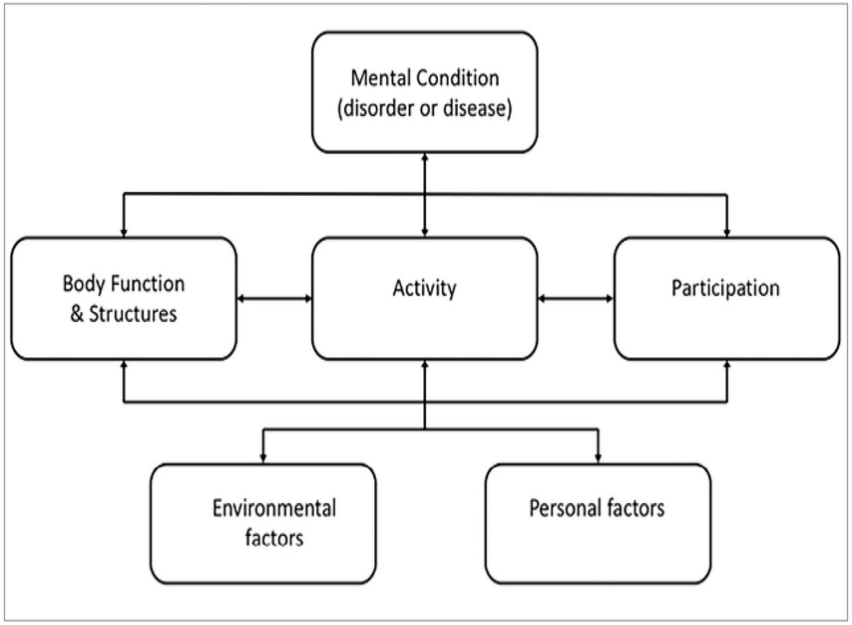
Tone Management Outcome Measures

International Classification of Functioning, Disability, and Health (ICF) Model



Body Function & Structures

Range of motion (ROM)

Strength

Modified Ashworth/Modified Tardieu (MAS/MTS)

Barry Albright Dystonia Scale (BAD)

Hypertonicity Assessment Tool (HAT)

Selective Control Assessment of Lower Extremities (SCALE)

Selective Control of Upper Extremities Scale (SCUES)

Activity

Gross Motor Function Measure (GMFM)

Functional Mobility Scale (FMS)

Manual Ability Classification System (MACS)

Participation

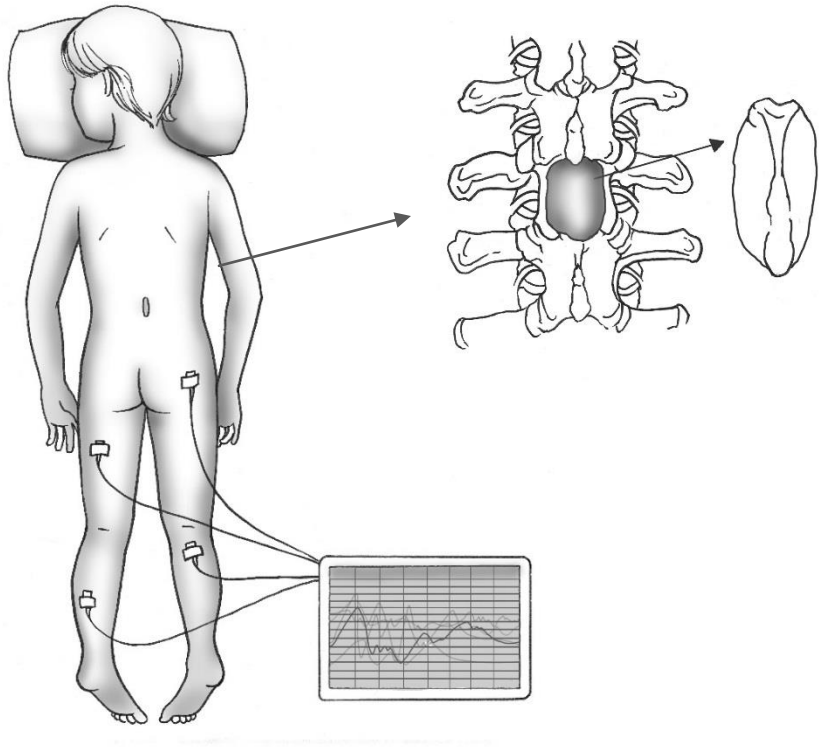
CP GOAL: Cerebral Palsy Gait Outcomes Assessment List

CPCHILD: Caregivers' Priorities and Child Health Index of Life with Disabilities

https://onlinelibrary.wiley.com/doi/epdf/10.1111/j.1469-8749.2008.03196.x

SDR – Surgical Approach[1, 2]

- General anesthesia
- Patient in prone position
- Neuro-monitoring team places electrodes
- 1-2 inch incision is made in the lumbar spine
- Single level laminectomy performed



1 Bales J, Apkon S, Osorio M, Kinney G, Robison R, A, Hooper E, Browd S, Infra-Conus Single-Level Laminectomy for Selective Dorsal Rhizotomy: Technical Advance. Pediatr Neurosurg 2016;51:284-291

2 Park TS, Gaffney PE, Kaufman BA, Molleston MC; Selective Lumbosacral dorsal rhizotomy immediately caudal to the conus medullaris for cerebral palsy spasticity. Neurosurgery 1993;33:929-933

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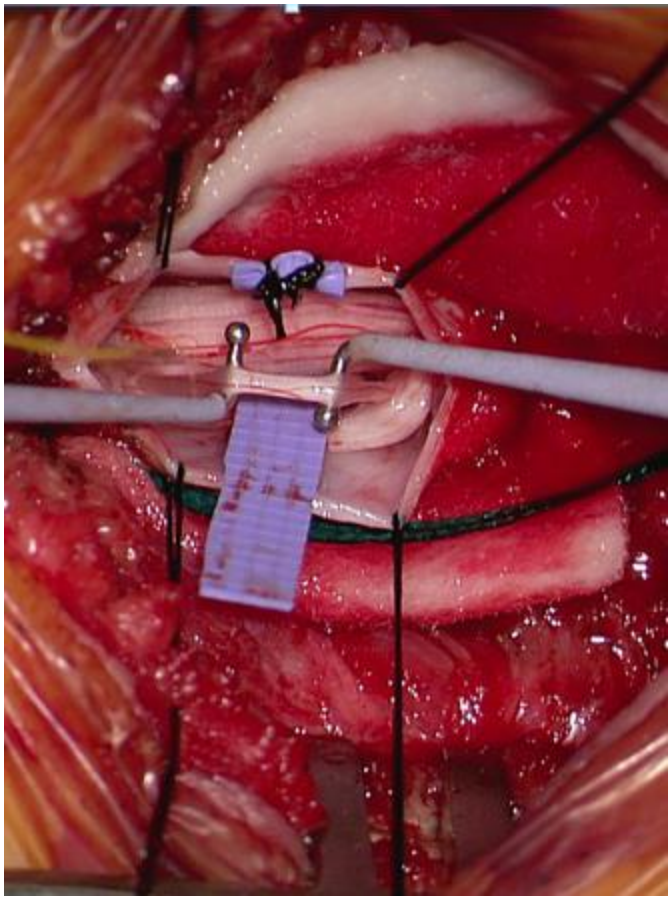
SDR – Surgical Approach (continued)

- Dorsal and ventral roots identified
  - Visually and electrically
    - Ventral roots activated at low threshold
  - Segmental level verified
- Ventral roots placed behind a silastic band



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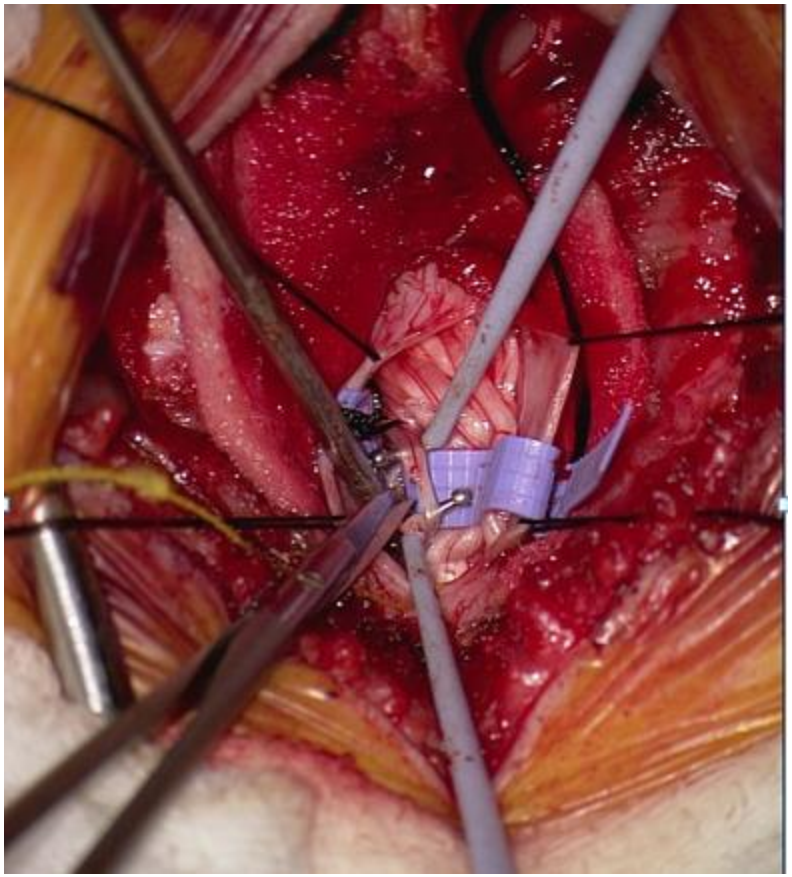
SDR – Surgical Approach (continued)

- Dorsal root teased into 3-8 rootlets
  - Rootlets looped and pulled away from CSF for stimulation and monitoring
  - Transection of the aberrant nerve roots[1]



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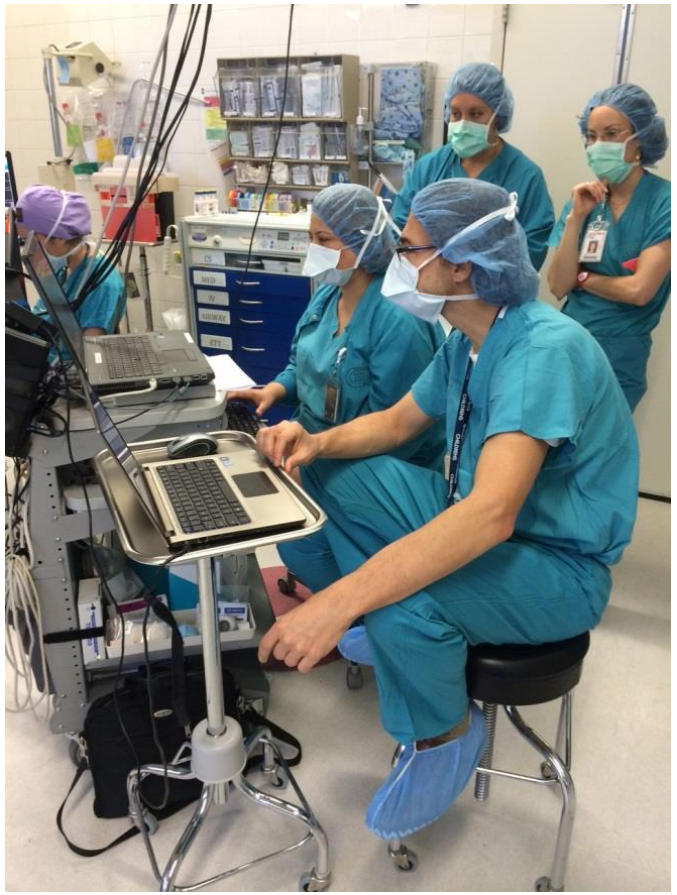
Intraoperative Monitoring

- Goal
  - Separate the ‘normal’ from the ‘abnormal’ by scoring system
  - Section the ‘most abnormal’ and leave the rest
  - 50-75% rootlets sectioned*



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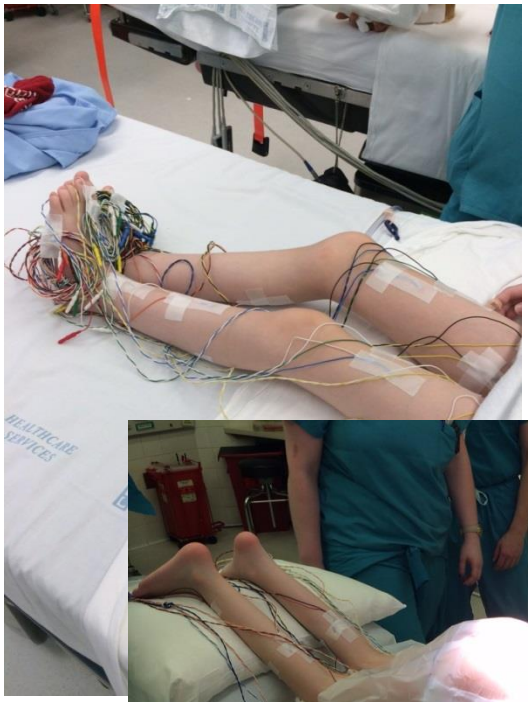
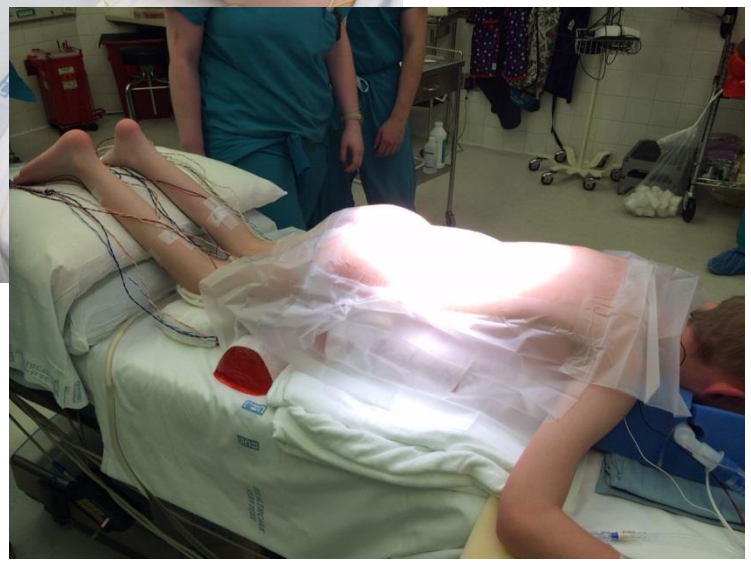
Intraoperative Monitoring (continued)

- Electrode placement – subdermal electrodes
  - L1/L2 – adductors
  - L2/L3 – vastus medialis
  - L4 – anterior tibialis
  - L5 – gastrocnemius
  - S1 – biceps femoris
  - S2/S3 – perirectal





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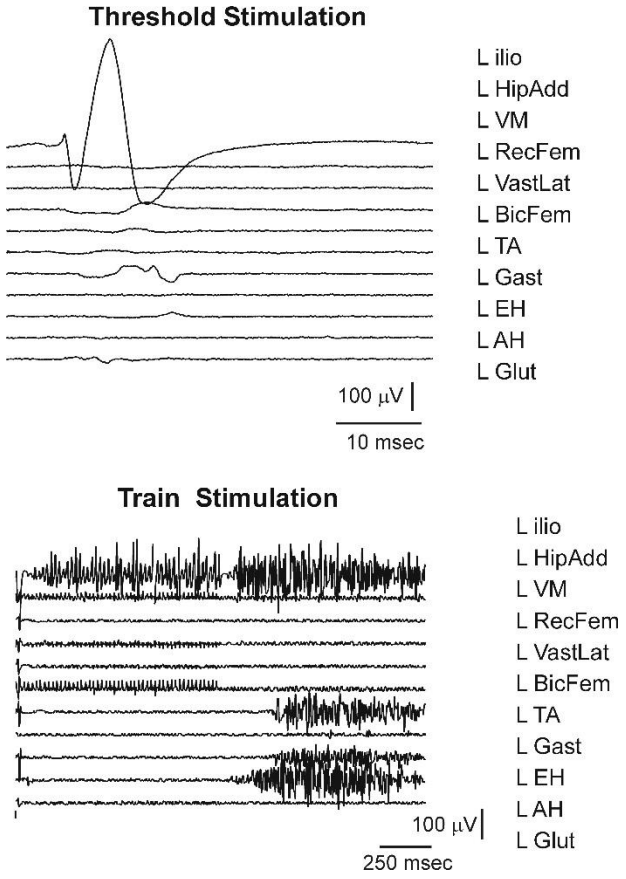
Nerve Root Selection Criteria

- Normal response
  - Single response to repetitive stimulation
  - Multiple response with decremental amplitude pattern
- Abnormal response
  - Incremental amplitude pattern
  - Motor response in non-targeted muscle
  - Response is sustained



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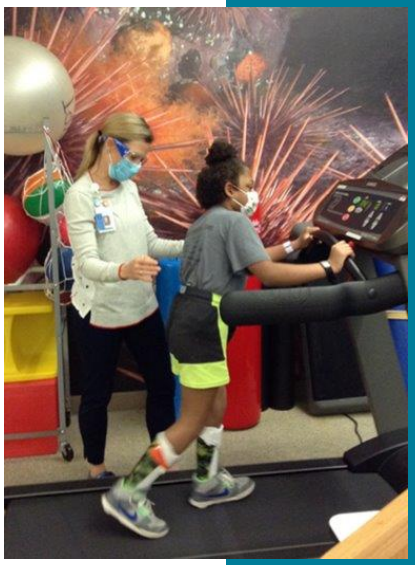
Rehabilitation after SDR



- NSR Service – approximately 3 days
  - Patient lays flat for 72 hours to prevent CSF leak
  - Can log roll
- RHB Service – approximately 3 weeks
  - Intensive inpatient rehab program
  - Option for outpatient therapy if patient/family unable to accommodate long term admission (case by case basis)
- Outpatient physical therapy 3-5 times a week for 6-12 months
- Follow up visit with the Surgical Tone Management team at 3, 6, 12, 18 and 24 months
- No evidenced based protocols exist

Outcomes of SDR

- Reduction in spasticity
- Improvement in ROM
- Functional improvement
- May decrease need for orthopedic surgery
- Functional gains maintained 17-26 years
- Improved gait kinematics

Buizer et al. 2016
Ingale et al. 2016
McLaughlin et al. 2002
O'Brien et al. 2005
Miller et al. 2017
Langerak N, et al. 2012
Novak, I, et al. 2019

SDR Outcomes – 5 and 10 year follow-up

- Spasticity reduction maintained
- Range of motion maintained or improved
- Motor function improvement in GMFM
  - A 7% improvement in GMFM score translates to a median positive change in function, positively impacting participation
  - SCH program average improvement in GMFM is 7%

Mittal S et al. J Neurosurg 2002; August; 97: 3153-25
Nordmark E et al. BMC Pediatrics 2008; 8:54.
Josenby AL et al. Dev Med Child Neuro 2012 May;54(5):429-35.
GMFM User's Manual, 2nd Ed. 2013:21

SDR – Theoretical Contraindications

- Presence/degree of dystonia
- Type of CP (hemiplegia, quadriplegia)
- Intellectual disability
- Age
- GMFCS levels IV-V
- Poor motor planning and excessive underlying weakness

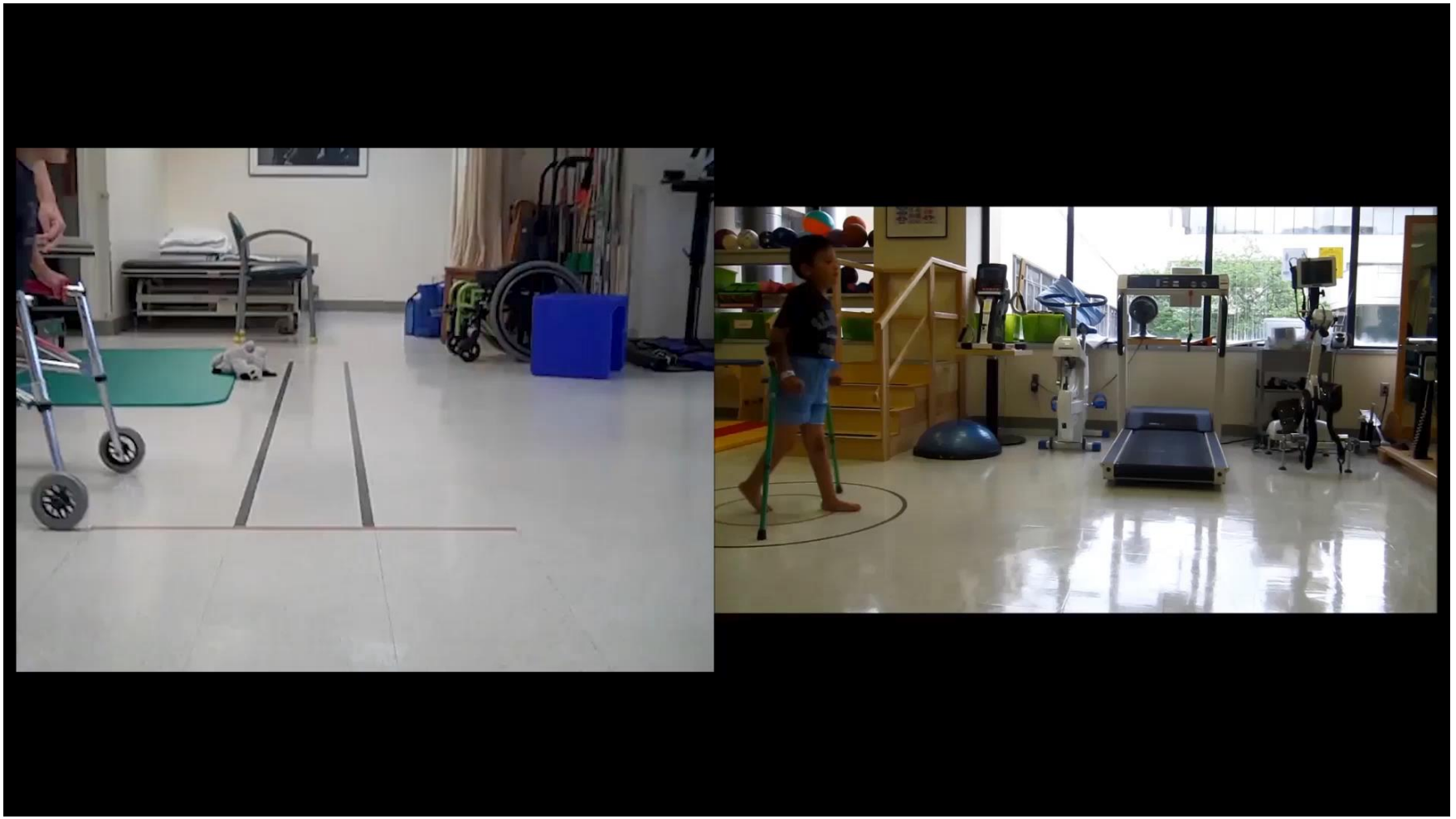
Kim HS, Steinbok P, Wickenheiser D. Childs Nerv Syst. 2006 Jan;22(1):60-66.
MacWilliams BA et al. Dev Med & Child Neuro. 2011; 53:717-723.

SDR - Potential Complications

- Infection[1]
- Spinal fluid leak
- Rare bladder incontinence
  - Transient urinary retention
- Back pain or other neuropathic pain

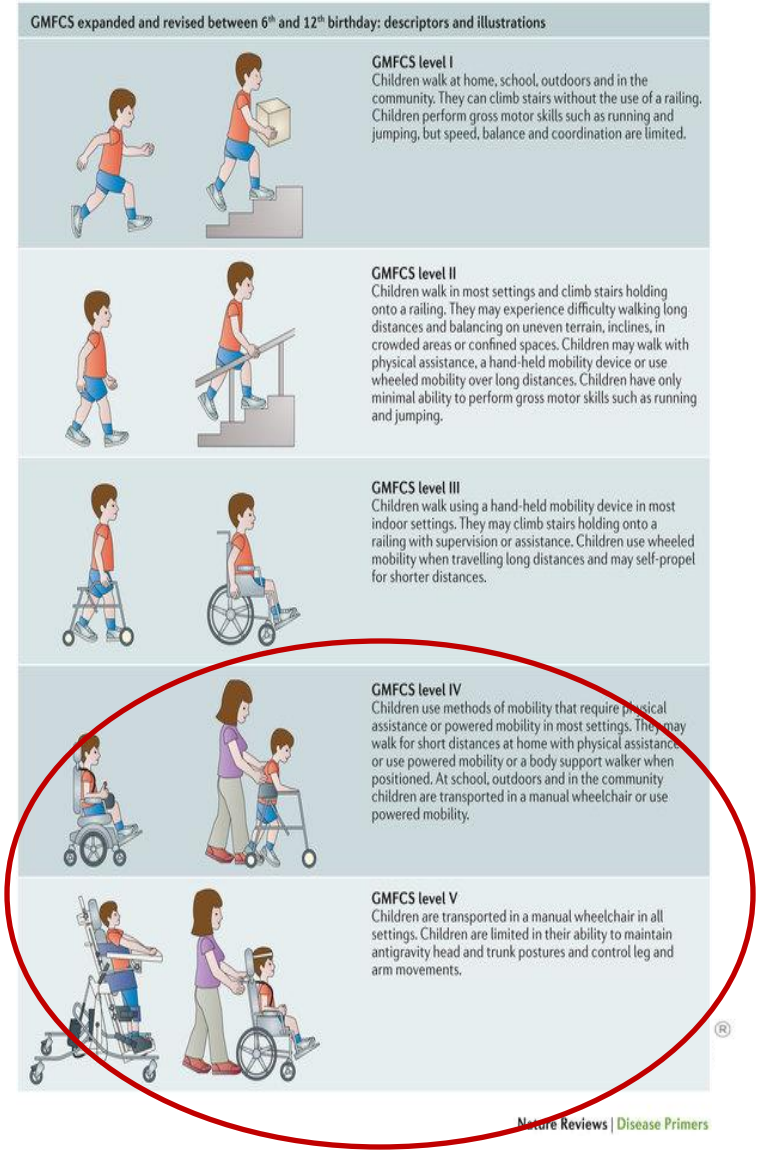
Bales J, Apkon S, Osorio M, Kinney G, Robison R, A, Hooper E, Browd S, Infra-Conus Single-Level Laminectomy for Selective Dorsal Rhizotomy: Technical Advance. Pediatr Neurosurg 2016;51:284-291

Patient AB – Before/After SDR



Palliative SDR in Moderate – Severe CP

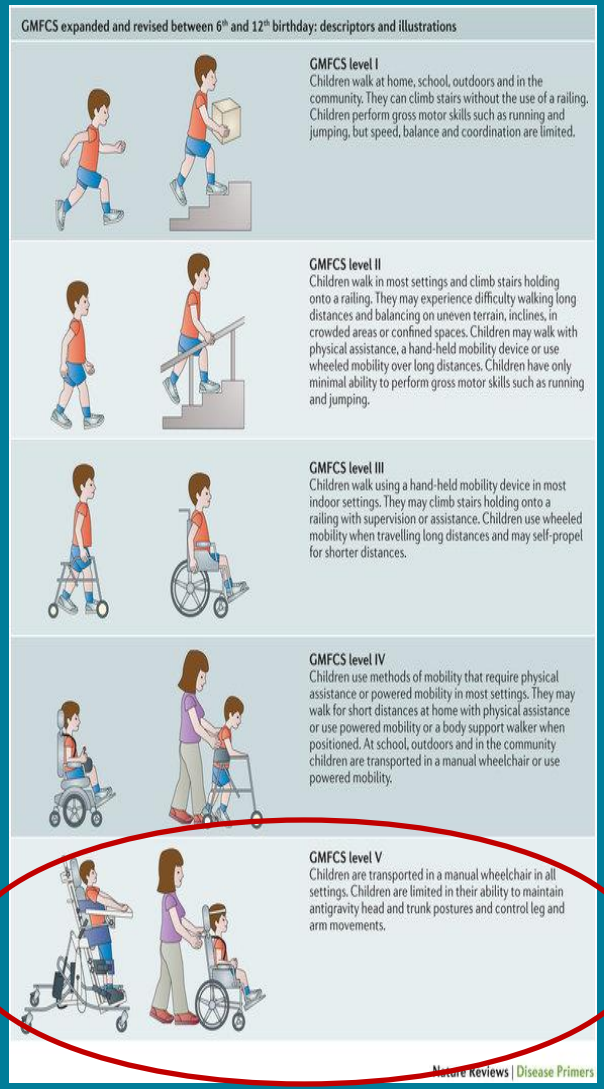
- Decreased spasticity, improved PROM
- High degree of patient satisfaction
- Potential option for non-ambulatory children in certain situations
  - Rural locations
  - No goals or potential for ambulation/weight-bearing



Kan P et al. Childs Nerv Syst. 2008; 24: 239-243.

Selective Dorsal Ventral Rhizotomy (SDVR)

- Done only for palliative goals and for patients with both spasticity AND dystonia
- Both DORSAL AND VENTRAL nerve roots are dissected
- Typically, 90% of ALL VENTRAL nerve roots and 75% of ALL DORSAL nerve roots are cut (per Gillette protocol/anecdotal evidence)
- No RHB provider present at time of surgery due to palliative goals
- Used when ITB not an option but does not preclude insertion of one if necessary
- SDVR offers significantly decreased healthcare costs and resource utilization relative to ITB



Hartman E. 2025

Summary

- ITB and SDR are effective interventions in reducing spasticity and improving function
- SDR offers the appropriate patients a single surgery with no device maintenance for primarily spastic patients
- SVDR may be an alternative to decrease dystonia/spasticity in GMFCS 5 patients with strict goals of care and cofort
- ITB is effective in managing upper AND lower extremity spasticity as well as dystonia (secondary)
- Long-term benefits of both interventions
- ITB complications fairly common, SDR complications rare
- Post-operative therapy post SDR in ambulatory patients (GMFCS 1-3) is critical to optimizing functional outcomes

Referral Algorithm: Hypertonia

Does the patient have hypertonia that interferes with mobility, positioning, or cares?

YES

What is the patient's gross motor classification?*

GMFCS IV or V

GMFCS I-III

Does the patient have care/comfort goals

YES

NO

Not a candidate for referral to Tone Management at this time

*Consider referral to **Rehabilitation Medicine** for a general rehab evaluation

NO

Does the patient have goals for ambulation or potential for ambulation with/without assistive devices?

YES

Is the patient at least 2 years old?

NO

Refer to Rehabilitation Medicine for a general rehab evaluation

YES

Has the patient tried other nonsurgical interventions such as oral medications, therapy, Botox/phenol injections?

YES

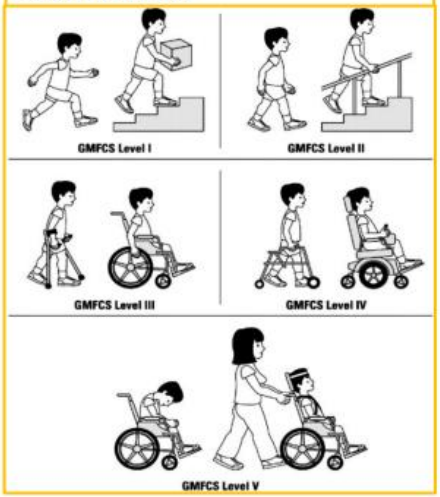
Refer to Surgical Tone Management (STM) Clinic for Selective Dorsal Rhizotomy (SDR) evaluation

NO

Refer to Rehabilitation Medicine for a general rehab evaluation

Refer to Surgical Tone Management (STM) Clinic for Intrathecal Baclofen (ITB) Therapy, Selective Dorsal Rhizotomy (SDR) or Selective Dorsal Ventral Rhizotomy (SDVR) evaluation

* Gross Motor Function Classification System (GMFCS)



To learn more

Scan QR Code

Refer a patient to the Tone Management Program in Rehab Medicine

Seattlechildrens.org/tone-management

How do I refer a patient for a surgical evaluation with the Tone Management team at Seattle Children's?

CALL (206) 987-5917

EMAIL tone@seattlechildrens.org

ONLINE REFERRAL FROM COMMUNITY PROVIDER:

Access referral instructions on www.seattlechildrens.org by searching "refer a patient" and selecting "Rehabilitation Medicine clinic"

To learn more

Scan QR Code

Refer a patient to the Tone Management Program in Rehab Medicine

Seattlechildrens.org/tone-management

References

- Vova JA, Green MM, Brandenburg JE, Davidson L, Paulson A, Deshpande S, Oleszek JL, Inanoglu D, McLaughlin MJ. A consensus statement on the use of botulinum toxin in pediatric patients. PM R. 2022 Sep;14(9):1116-1142. doi: 10.1002/pmrj.12713. Epub 2021 Nov 26. PMID: 34558213.
- Multani I, Manji J, Tang MJ, Herzog W, Howard JJ, Graham HK. Sarcopenia, Cerebral Palsy, and Botulinum Toxin Type A. JBJS Rev. 2019 Aug;7(8):e4. doi: 10.2106/JBJS.RVW.18.00153. PMID: 31415277.
- Graham HK, Rosenbaum P, Paneth N, Dan B, Lin JP, Damiano DL, Becher JG, Gaebler-Spira D, Colver A, Reddihough DS, Crompton KE, Lieber RL. Cerebral palsy. Nat Rev Dis Primers. 2016 Jan 7;2:15082. doi: 10.1038/nrdp.2015.82.
- Green LB, Hurvitz EA. Cerebral palsy. Phys Med Rehabil Clin N Am. 2007 Nov;18(4):859-82, vii. doi: 10.1016/j.pmr.2007.07.005. PMID: 17967366.
- Fehlings D, Agnew B, Gimeno H, Harvey A, Himmelmann K, Lin JP, Mink JW, Monbaliu E, Rice J, Bohn E, Falck-Ytter Y. Pharmacological and neurosurgical management of cerebral palsy and dystonia: Clinical practice guideline update. Dev Med Child Neurol. 2024 Sep;66(9):1133-1147. doi: 10.1111/dmcn.15921. Epub 2024 Apr 19. PMID: 38640091; PMCID: PMC11579811.
- Gillespie CS, Hall BJ, George AM, Hennigan D, Sneade C, Cawker S, Silva AHD, Vloeberghs M, Aquilina K, Pettorini B. Selective dorsal rhizotomy in non-ambulant children with cerebral palsy: a multi-center prospective study. Childs Nerv Syst. 2024 Jan;40(1):171-180. doi: 10.1007/s00381-023-06062-4. Epub 2023 Jul 13. PMID: 37439914; PMCID: PMC10761507.
- Mansur A, Morgan B, Lavigne A, Phaneuf-Garand N, Diabira J, Yan H, Narayanan UG, Fehlings D, Milo-Manson G, Dalziel B, Breitbart S, Mercier C, Venne D, Marois P, Weil AG, Raskin JS, Thomas SP, Ibrahim GM. Comparison of intrathecal baclofen pump insertion and selective dorsal rhizotomy for nonambulatory children with predominantly spastic cerebral palsy. J Neurosurg Pediatr. 2022 Jun 3;30(2):217-223. doi: 10.3171/2022.4.PEDS21576. PMID: 35901772.
- Hartman E, Ruppert-Gomez M, Mosher A, Buxton K, Morgan A, Stone S, Northam WT. Intrathecal baclofen pump versus combined dorsal/ventral rhizotomy for spastic quadriplegia: healthcare cost and complication analysis. J Neurosurg Pediatr. 2025 May 16;36(2):217-224. doi: 10.3171/2025.2.PEDS24576. PMID: 40378465.
- Rohde MA, Santos RC, Lindner RJ, Ribeiro CM, Custódio CS, Feijó FV, Corte AD. The use of DBS in the treatment of childhood cerebral palsy: a systematic review. Childs Nerv Syst. 2025 May 23;41(1):187. doi: 10.1007/s00381-025-06852-y. PMID: 40407856.
- McLaughlin J, Bjornson K, Temkin N, Steinbok P, Wright V, Reiner A, Roberts T, Drake J, O'Donnell M, Rosenbaum P, Barber J, Ferrel A. Selective dorsal rhizotomy: meta-analysis of three randomized controlled trials. Dev Med Child Neurol. 2002 Jan;44(1):17-25. doi: 10.1017/s0012162201001608. PMID: 11811645.

References

- Mishra D, Barik S, Raj V, Kandwal P. A systematic review of complications following selective dorsal rhizotomy in cerebral palsy. Neurochirurgie. 2023 May;69(3):101425. doi: 10.1016/j.neuchi.2023.101425. Epub 2023 Feb 23. PMID: 36828056.
- MacWilliams BA, McMulkin ML, Duffy EA, Munger ME, Chen BP, Novacheck TF, Schwartz MH; Selective Dorsal Rhizotomy Outcomes Research Team. Long-term effects of spasticity treatment, including selective dorsal rhizotomy, for individuals with cerebral palsy. Dev Med Child Neurol. 2022 May;64(5):561-568. doi: 10.1111/dmcn.15075. Epub 2021 Nov 10. PMID: 34755903.
- Novak I, Morgan C, Fahey M, Finch-Edmondson M, Galea C, Hines A, Langdon K, Namara MM, Paton MC, Popat H, Shore B, Khamis A, Stanton E, Finemore OP, Tricks A, Te Velde A, Dark L, Morton N, Badawi N. State of the Evidence Traffic Lights 2019: Systematic Review of Interventions for Preventing and Treating Children with Cerebral Palsy. Curr Neurol Neurosci Rep. 2020 Feb 21;20(2):3. doi: 10.1007/s11910-020-1022-z. PMID: 32086598; PMCID: PMC7035308.